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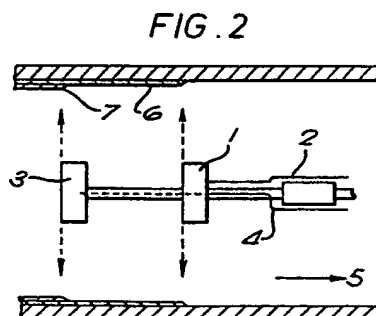
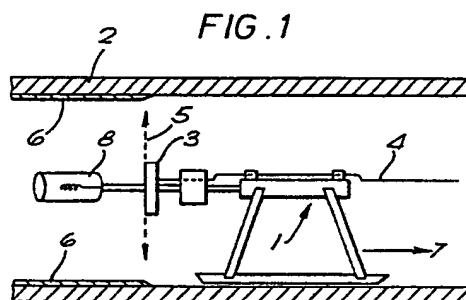
(58) Field of search

UK CL (Edition J) F2G G41, F2P PTBL

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(54) Lining pipes

(57) Pipes are lined by applying an anaerobic and/or photocurable layer(s) 6, 7 using a pig or carriage 1. The pig may comprise one or two spray heads 3 and a U.V. source 8.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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FIG. 1

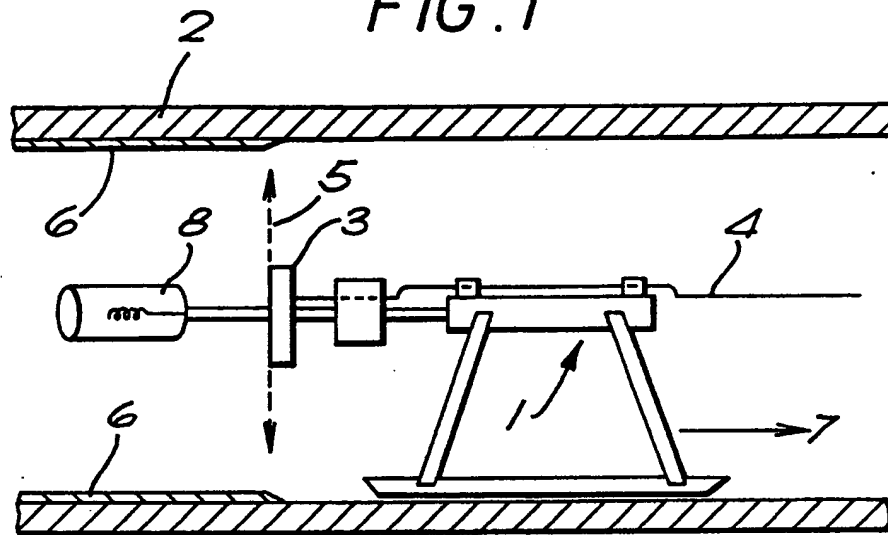
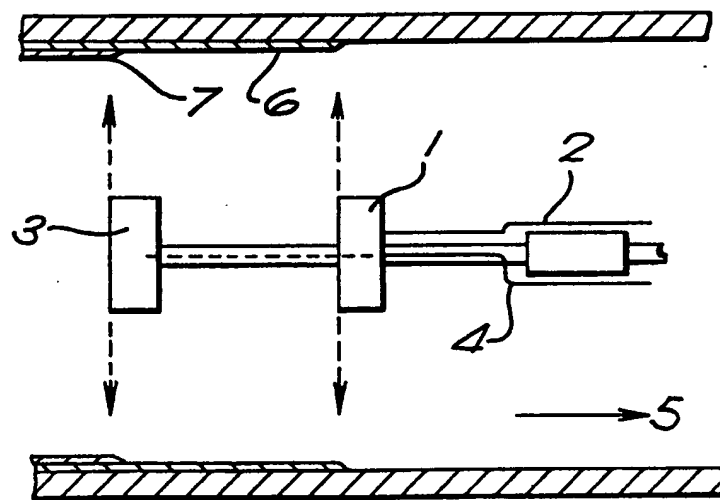


FIG. 2



A METHOD FOR INTERNALLY COATING ENCLOSURES SUCH AS PIPES

The present invention relates to a method for forming a polymer lining inside an enclosure, particularly a pipe, utilising curable compositions. More particularly it relates to internally coating or sealing pipes and pipelines with a polymer composition.

It is a common occurrence for pipes such as water mains, gas main, sewer pipes, slurry pipes and effluent pipes to leak. This is particularly inconvenient when the pipes are laid underground. Leaks occur at joints (such as lead/yarn or rubber gaskets), where the jointing material has degraded or failed in other ways. Leakage is also caused by structural damage and by corrosion to the pipe material.

Methods for the sealing of individual leaks or re-lining entire pipelines commonly use spray application of curable resin compositions onto the inner walls of the pipe. Examples of these are described in GB Patent 2160289B. The sealants or coatings commonly used take the form of curable epoxy or polyurethane resins having two components which have to be mixed together prior to application to produce a chemical curing reaction. After curing the resins form a solid polymer coating inside the pipe. The choice of a particular curable resin depends on the type of pipe being coated and on the material being transported within it. The choice of a suitable material is well within the competence of those practised in the art.

In the sealing of discrete joints, holes or cracks the sealant coating adhesively bonds all around the leakage position so that the fluid cannot escape and so that hydrostatic pressure from water surrounding the pipe cannot enter the pipe. The sealant must also accommodate movement of the pipe around the joint or crack. It also has to be resistant to the material being carried by the pipe.

In the situation where pipes are being re-lined the requirements of the cured polymer are most often that it should have structural strength substantially equivalent to that of the surrounding pipe. For example, a new pipe can be created inside an existing ceramic sewer pipe.

In addition to the requirements of individual seals and structural re-lining, materials of intermediate structural properties are required. Examples of these are gas main linings and abrasion resistant linings.

Newly manufactured pipes often need to be protected by internal coatings prior to installation. The type of coatings often required are corrosion or abrasion resistant linings. The spray application devices used to coat the inside of new or installed pipes most often take the form of spray nozzles, rotating cones, drums or discs which produce droplets of resin that impinge on the inner walls of the pipe to form a coating. These devices are well known to those skilled in the art. The spray application head is usually located on a support or carriage. This is moved along the pipe by being self driven or by being hauled.

The spray head is usually supplied with the components of the curable resin and powered electrically,

pneumatically or hydraulically. The resin components are usually supplied to the hoses by pumping machines located outside the pipe.

5 The components of the resin have to be metered and delivered to the applicator by high pressure pumping equipment.

10 Whilst these methods and coating compositions represent an important advance in the art there are, nevertheless, some drawbacks in their usage. One drawback is that the metering pumps are somewhat expensive and cumbersome to use. A further drawback is that the components of the resin require thorough mixing before being fed into the spray head. Mixing is commonly achieved by using static mixers located before the mixing head.

15 More recently an important advance in the art has been a method of mixing inside a rapidly spinning cone (see patent GB 2160289B).

20 In all these devices thorough mixing must be guaranteed because partially mixed resins have much reduced mechanical and chemical properties. Therefore there exists a need for a more cost effective internal coating application method, which does not require large and expensive metering pumps,

25 The present invention eliminates the need for metering and mixing by employing curable compositions that are anaerobically cured or cured by light, particularly ultraviolet (U.V.) light.

In accordance with the present invention, there is provided a method of lining an enclosed space such as a pipe with a polymeric material, which method comprises

applying to an interior surface defining the space a coating of composition capable of anaerobic curing to form the polymeric material, and excluding oxygen from the coating to cure the composition, or

- 5 applying to an interior surface defining the space a sprayed coating of a composition which is capable of being cured on exposure to light to form the polymeric material and thereafter exposing the coating to light to cure the composition.

- 10 It is unexpectedly found that the aforementioned curable compositions can be embodied as gels or pastes which can be sprayed onto the inner walls of pipes using conventional spraying equipment to form thick coatings. These coatings can subsequently be cured into solid
15 polymers with the desired properties, anaerobically or by U.V. light.

- In a first aspect of this invention, an anaerobic composition is employed. Suitable anaerobic compositions preferably contain acrylate or methacrylate functional
20 groups. These compositions polymerise to form a solid polymer when air is excluded.

- A second aspect of the invention relates to the use of photocurable compositions, particularly such compositions which cure when exposed to UV light. Such compositions are
25 generally similar to anaerobic compositions, in that they preferably contain curable acrylate and methacrylate monomers and often oligomers and polymers.

- The formulation of the composition may be adjusted to give cured polymers having different properties varying
30 between elastomers and hard rigid materials. The

compositions will generally contain initiators, accelerators and stabilisers.

Suitable stabilisers for both types of compositions are free radical stabilisers such as hydroquinone, or chelating agents such as EDTA.

Suitable photoinitiators include those well known to those skilled in the art, such as phosphine oxides. Suitable initiators for anaerobic compositions are also well known to those skilled in the art and include peroxides, such as cumene hydroperoxide.

Suitable accelerators for anaerobic compositions include bases such as benzoic sulphamide, and amines such as dimethyl paratoluidene.

Both anaerobic and U.V. curable compositions may contain polymers and inorganic materials to modify the properties of the cured polymer and to reduce the cost of the final product. They may also contain adhesion promoters, the nature of which depends on the substrate being coated.

The compositions may be formed into a gel or paste by the incorporation of a thickening or gelling agent, preferably fumed silicon dioxide. The thixotropic index (quotient of viscosity measured at two different shear rates) of the gelled composition is preferably greater than 1, more preferably greater than 3 (Brookfield viscometer, 25°C, 2.5 rpm and 20 rpm), so that when the composition is sprayed it forms a non-sagging coating. The amount of thickening or gelling agent incorporated may be varied depending on the coating thickness required. Coating thickness varying between 0.1 mm to 50 mm can be formed

using the aforementioned compositions.

Gelled compositions of the type described usually have the desirable property of a low base viscosity, (i.e. viscosity of the composition in the absence of gelling agents), a typical value being of the order of less than 100, more preferably less than 50 millipascalseconds (Brookfield viscometer, 25°C, 2.5 rpm).

The base viscosity is experienced at the relatively low shear rates experienced by the composition when it is pumped along hoses. This gives advantages of reduced pumping pressures which then enables the use of smaller diameter hoses or smaller pumps.

Gelled compositions have a further advantage over mixed reaction curing resin compositions in that the curing can be initiated quite a long time after application. This enables post application operations to be carried out before the composition cures into a solid polymer. These operations may include checking the coating for soundness. The coating can also be worked by means such as trowelling to smooth the coating over gaps or protrusions in the pipe.

The method of the invention may be carried out by employing spraying apparatus of generally known kind, except that no metering pumps are needed and no mixing is required immediately prior to spraying. Once the coating has been applied it may be cured by excluding oxygen from the pipe or by light, as appropriate. Exclusion of oxygen may be achieved by purging the air from the pipe and replacing it with a non-oxygen containing fluid such as nitrogen or natural gas. Alternatively a cured polymer can be produced by spraying the composition under a non-oxygen

containing atmosphere such as found inside a natural gas pipeline. In this saturation the composition will cure at a rate determined by the initiators, accelerators and stabilisers that it contains.

5 When photo-curing is employed, this may be effected by illumination from a U.V. light source located on the application carriage such that the U.V. light source follows the spray head device.

10 In accordance with a further aspect of the invention, there is provided apparatus for applying an anaerobically curable composition to an internal surface of a pipe, comprising

 a carriage for passing through the pipe,
 a spray head mounted on the carriage, for applying a
15 photocurable composition to the internal surface of the pipe, and
 a light source mounted on the carriage, for irradiating the photocurable composition.

20 In accordance with yet a further aspect of the invention, there is provided apparatus for applying an anaerobically curable composition to an internal surface of a pipe, comprising

 a carriage for passing through the pipe,
 a first spray head mounted on the carriage, for
25 applying a first layer of a photocurable composition to the internal surface of the pipe, and

 a second spray head mounted on the carriage for applying a second layer of a photocurable composition to the internal surface of the pipe,

wherein the first and second spray heads are adapted to apply the said compositions at positions spaced axially along the pipe.

A preferred embodiment of this invention will now be
5 described with reference to the accompanying drawings, in which:-.

Figure 1 shows apparatus according to a first aspect of this invention, and

Figure 2 shows apparatus according to an alternative
10 aspect of the invention.

Referring first to Figure 1, a spray carriage 1 is located inside a pipe 2. The spraying head 3, is mounted on carriage 1, centrally located in the pipe, and is fed with a U.V. curable composition by the hose 4. The coating
15 is sprayed onto the pipe 5, from the spray head 3. The coating 6, is applied in the direction shown by 7. The coating is cured by radiation emitted from the U.V. source 8, in a 360 degree pattern. Designs for the supporting carriage are well known to those skilled in the art.

20 Anaerobically curable and U.V. curable coatings can be applied in a single continuous pass of the spray head but it is preferably applied in multiple passes to produce a smoother coating. This is done by reciprocating the head longitudinally on the carriage as it travels along the
25 pipe.

The invention has a further advantage in that coatings made of layers of polymer of different properties can be applied. Thus coatings of a composite nature are produced. This may be used for sealing leaking joints in which the
30 ends of the joint move relative to each other.

Here an elastomer can be applied directly onto the joint with portions adhesively bonded to either side. The elastomeric nature of this first layer would accommodate stresses produced by joint movements. On top of this and
5 adhesively bonded to it a structurally stronger layer is applied. The stronger layer provides support against a hydrostatic pressure from surrounding water which is often present around buried pipelines.

An embodiment of this variation of the method of the
10 invention is described with reference to Figure 2. The first layer of a particular composition is applied by spray head 1 which is fed by hose 2. The second layer of different composition is applied on top of the joint by the spray head 3, which is fed by hose 4. The direction of
15 carriage travel is shown by 5. Curing of this type of composite coating is achieved anaerobically or by U.V. light as previously described. The first layer of the coating of a particular composition is 6, the second layer of different composition is 7.

20 A number of preferred compositions for use with the present invention will now be described in the following examples.

Example 1 UV curable Elastomeric coating for adhesion to metal pipes.

Parts by weight

	Ethyl Hexyl Acrylate	35
	Urethane acrylate oligomer	
5	(¹ Ebecryl 230)	33
	B-Carboxyethyl Acrylate	18
	Methacryloxy ethyl phosphate	6
	Fumed silicon dioxide (² Aerosil R974)	7
	2,4,6 Trimethylbenzoyldiphenyl oxide	1

10

1- Trade Mark of UCB Chemicals

2- Trade Mark of Degussa.

15 A 5 mm thick coating was irradiated with Ultra Violet
light of intensity of approximately 10 m/cm over a
wavelength range 350 nm to 450 nm and found to cure within
30 seconds.

Example 2 UV curable Structurally strong coating for
adhesion to ceramic pipes

	<u>Parts by</u>
	<u>weight</u>
5	
Epoxy acrylate oligomer (³ ACTOCRYL 100)	51
Triallyl Cyanurate	42
Fumed Silica	5
10 Gamma-glycidoxypropyl trimethoxysilane	1
2,4,6 Trimethyl benzoyldiphenyl phosphine oxide	1

3- Trade Mark of Ancomer Chemicals.

15 A coating of 5mm thickness was irradiated with Ultra
Violet light of intensity of approximately 10mW/cm over a
wavelength range 350 Nm to 450 Nm and found to cure within
360 seconds.

20

Example 3 Anaerobically cured structurally strong
coating for metal pipes

		<u>Parts by weight</u>
5	Hydroxy propyl methacrylate	31
	Ethyl hexyl methacrylate	50
	Aerosil R974	10
	Methacryloxy ethyl phosphate	5
10	Stabilizers	1
	Dimethyl paratoluidine	1
	Benzoic sulphamide	1
	Cumene hydroperoxide	1

15

A coating of 5 mm thickness was found to cure to a solid
polymer within 5 days on the exclusion of oxygen.

CLAIMS

1. A method of lining an enclosed space with a polymeric material, which method comprises
 - 5 applying to an interior surface defining the space a coating of composition capable of anaerobic curing to form the polymeric material, and excluding oxygen from the coating to cure the composition, or
 - 10 applying to an interior surface defining the space a sprayed coating of a composition which is capable of being cured on exposure to light to form the polymeric material and thereafter exposing the coating to light to cure the composition.
2. A method as claimed in Claim 1, wherein the polymer
15 composition is U.V. curable, and the coating is exposed to U.V. light.
3. A method as claimed in claim 1 or claim 2, wherein the composition has a thixotropic index of greater than 3.
4. A method as claimed in any one of the preceding
20 claims, wherein the composition has a base viscosity (as hereinbefore defined of less than 100 millipascalseconds.
5. A method as claimed in any one of the preceding claims, wherein the enclosed space is the interior of a pipe.
- 25 6. A method of lining an enclosed space with a polymeric material, substantially as hereinbefore described, with reference to the Figure 1 or Figure 2 of the accompanying drawings.
7. Apparatus for applying an anaerobically curable
30 composition to an internal surface of a pipe, comprising

a carriage for passing through the pipe,
a spray head mounted on the carriage, for applying a
photocurable composition to the internal surface of the
pipe, and

- 5 a light source mounted on the carriage, for irradiating
the photocurable composition.

8. Apparatus for applying an anaerobically curable
composition to an internal surface of a pipe, comprising
a carriage for passing through the pipe,

- 10 a first spray head mounted on the carriage, for applying
a first layer of a photocurable composition to the internal
surface of the pipe, and

a second spray head mounted on the carriage for applying
a second layer of a photocurable composition to the
15 internal surface of the pipe,

wherein the first and second spray heads are adapted to
apply the said compositions at positions spaced axially
along the pipe.

9. Apparatus for lining an enclosed space with a
20 polymeric material, substantially as hereinbefore
described, with reference to the Figure 1 or Figure 2 of
the accompanying drawings.